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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 10/081,312
Filing Date: February 21, 2002
Appellant(s): BANG ET AL.

MAILED

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GROUP 1700

Keith Taboada
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 9/8/2006, correcting the appeal brief filed 1/12/05 appealing from the Office action mailed 7/23/04.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

JP 409328382 A

6139983	Ohashi et al.	10-2000
6287683	Itoh et al.	9-2001

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4637684	Tomita et al.	1-1987
6162495	Morton	12-2000
5643483	Kubota et al.	7-1997
6215806	Ohmi et al.	4-2001
5958155	Kawamata et al.	9-1999

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

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3. Claims 1 – 7, 10 – 13, and 16 – 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Toyoda et al. (JP 09-328382 A) in view of Ohashi et al. (USPN 6,139,983), and in further view of Itoh et al. (USPN 6,287,683 B1), Tomita et al. (USPN 4,637,684), and Morton (USPN 6,162,495).
4. Regarding independent **Claim 1**, Toyoda et al. teaches a method of forming a coated part, specifically an aluminum nitride base material used as a susceptor in semiconductor fabrication processes such as CVD and dry etching (paragraphs [0001], [0007], and [0008]), the method comprising the step of coating the aluminum nitride base material with a magnesium fluoride coating “14” by a vacuum deposition method or a sputtering method (Figure 1, paragraphs [0006] – [0008], [0011] – [0012], and [0014]). This magnesium fluoride coating functions to protect the aluminum nitride component from corrosive fluorine-containing gases present during CVD or etching operations (i.e., the coating reduces corrosion of the component upon exposure to a corrosive environment) (paragraphs [0004], [0005], and [0008]). Toyoda et al. does not explicitly teach that the magnesium fluoride coating has a density of at least about 85% and a purity of at least about 99%. Specifically, Toyoda et al. is silent regarding the density and purity of the magnesium fluoride coating, as well as the specific process conditions (e.g., temperature and pressure) used to deposit the coating. However, Toyoda et al. does teach that the magnesium fluoride target used in the deposition process has a purity of 99.5% (paragraph [0014]). This teaching would at least suggest to one of ordinary skill in the art that Toyoda et al. is concerned with and desires depositing a coating having a high purity. Ohashi et al.

teaches an analogous process of coating a wafer-supporting member with a magnesium fluoride layer in order to protect the member from corrosion by halogen-containing gases (Abstract, Col.1, lines 53 – 67, Col.2, lines 1 – 8, and Col.3, lines 31 – 61). Ohashi et al. teaches that the method of producing the fluoride layer should be such that defects and pin-holes are not formed in the film (Col.6, lines 15 – 27). Therefore, it would have been obvious to one of ordinary skill in the art to desire to deposit / form the magnesium fluoride coating of Toyoda et al. in such a manner that the coating is free of defects and pin-holes (as taught to be desirable by Ohashi et al.) so that the coating provides the aluminum nitride component with optimum corrosion resistance. As a denser, more highly packed coating would be expected to have fewer defects (e.g., voids, holes) and pin-holes than a porous, less dense coating, it would also have been obvious to one of ordinary skill in the art to desire to deposit / form the magnesium fluoride coating of Toyoda et al. in such a manner that the coating is sufficiently dense to minimize or eliminate defects, such as voids, and pin-holes in the coating. Itoh et al. teaches that, in the art of depositing a magnesium fluoride film by vacuum deposition, EB deposition, sputtering, etc., the packing rate / density of the film can be adjusted by controlling the degree of vacuum (i.e., the pressure) and the film-forming temperature during the process (Col.4, lines 64 – 67, Col.5, lines 1 – 24). In other words, Itoh et al. teaches that the temperature and pressure in a magnesium fluoride deposition process are result / effective variables that are used to control the density of the deposited film. The lower the degree of vacuum (i.e., the higher the pressure) and the lower the film-

forming temperature, the lower the density of the deposited film (Col.5, lines 10 – 14). Consequently, the lower the pressure and the higher the temperature, the higher the density of the deposited film. Tomita et al. teaches that a magnesium fluoride film of low porosity (i.e., high density) can be deposited on a substrate by heating the substrate to the order of 300° C during deposition (Col.4, lines 39 – 54). Additionally, Morton teaches that, by using a low pressure of 10^{-6} torr or less during a magnesium fluoride deposition process, a pure, dense magnesium fluoride film can be formed (e.g., without contaminants such as oxygen or hydrogen) (Col.3, lines 48 – 66). As such, it would have been obvious to one of ordinary skill in the art to optimize as result / effective variables the temperature and pressure of the magnesium fluoride deposition process of Toyoda et al. through routine experimentation in order to obtain an optimized magnesium fluoride coating that has both a high purity and density (i.e., free of defects and pin-holes), as desired by the combination of Toyoda et al. and Ohashi et al. In doing so, one of ordinary skill in the art would have optimized the temperature to be, for example, on the order of 300° C (as taught by Tomita et al.) and the pressure to be, for example, 10^{-6} torr or less (as taught by Morton) during the magnesium fluoride deposition process because Tomita et al. and Morton et al. teach that these temperatures and pressures are suitable for depositing a dense, pure magnesium fluoride film, as desired by the combination of Toyoda et al. and Ohashi et al. The deposition of a magnesium fluoride coating at these process conditions would have inherently produced a magnesium fluoride coating having a density of at least about 85% and a purity of at

least about 99%, as required by Claim 1, because the aforementioned magnesium fluoride deposition process conditions are identical to the applicant's disclosed magnesium fluoride deposition process conditions that achieve the claimed coating density and purity (see, for example, paragraphs [0021], [0023], and [0025] of the applicant's specification). Regarding **Claims 2 and 3**, the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton does not explicitly teach that the magnesium fluoride coating has a density of between about 85 – 90% (Claim 2) or about 100% (Claim 3). However, as fully set forth above in the discussion of Claim 1, it would have been obvious to one of ordinary skill in the art to optimize as result / effective variables the temperature and pressure of the magnesium fluoride deposition process of Toyoda et al. through routine experimentation in order to obtain an optimized magnesium fluoride coating that has both a high purity and density (i.e., free of defects and pin-holes), as desired by the combination of Toyoda et al. and Ohashi et al. The exact density (e.g., between about 85 – 90%, or about 100%) would have been determined and optimized by one of ordinary skill in the art based upon the specific temperature and pressure used in the deposition process. Regarding **Claim 4**, Toyoda et al. also teaches that the corrosive environment comprises fluorine (paragraphs [0005] and [0008]). Regarding **Claims 5 and 6**, the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton also teaches that the coating step is performed at a pressure of not more than about 1×10^{-5} torr (Claim 5) and at a temperature of at least 250° C (Claim 6) (see the discussion of Claim 1 above). Regarding **Claim 7**, Toyoda et al. also teaches that

the component part comprises aluminum nitride or aluminum (paragraphs [0001] and [0014]). Regarding **Claims 10 and 12**, the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton also teaches that the coating step comprises coating the component by chemical vapor deposition or physical vapor deposition (e.g., sputtering) (paragraphs [0006] – [0008], [0011] – [0012], and [0014] of Toyoda et al.; Col.4, lines 64 – 67, Col.5, lines 1 – 24 of Itoh et al.). Regarding **Claim 11**, the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton also teaches that the chemical vapor deposition coating is performed at a temperature of at least about 300° C (Col.4, lines 39 – 54 of Tomita et al.). Regarding **Claim 13**, the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton does not explicitly teach that the PVD coating is performed at a temperature of at least about 600° C. However, as fully set forth above in the discussion of Claim 1, it would have been obvious to one of ordinary skill in the art to optimize as result / effective variables the temperature and pressure of the magnesium fluoride deposition process of Toyoda et al. through routine experimentation in order to obtain an optimized magnesium fluoride coating that has both a high purity and density (i.e., free of defects and pin-holes), as desired by the combination of Toyoda et al. and Ohashi et al. Regarding **Claims 16 and 17**, the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton does not explicitly teach that the coating has a grain size of less than about 30 microns, particularly less than about 3 microns. However, the deposition process conditions taught by the aforementioned combination of references (i.e., a

temperature on the order of 300° C (as taught by Tomita et al.) and a pressure of, for example, 10⁻⁶ torr or less (as taught by Morton)) would have inherently produced a magnesium fluoride coating having the grain size claimed by the applicant, because the aforementioned magnesium fluoride deposition process conditions are identical to the applicant's disclosed magnesium fluoride deposition process conditions used to obtain the claimed coating. Regarding **Claims 18 and 19**, the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton also teaches that the coating has a thickness of less than about 2 microns, particularly less than about 1 micron (Abstract; paragraphs [0012] and [0014] of Toyoda et al.).

5. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Toyoda et al. (JP 09-328382 A) in view of Ohashi et al. (USPN 6,139,983), in further view of Itoh et al. (USPN 6,287,683 B1), Tomita et al. (USPN 4,637,684), and Morton (USPN 6,162,495), and in further view of Kubota et al. (USPN 5,643,483).
6. The combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton teaches all the limitations of **Claim 8** as set forth above in paragraph 10, except for a method wherein the component part (i.e., the susceptor / wafer holder of Toyoda et al.) has a surface finish of less than about 10RA (i.e., a roughness of 10 microinches, or 0.254 μm). Specifically, the aforementioned combination of references is silent regarding the surface finish (i.e., roughness) of the susceptor to be coated. However, Kubota et al. teaches that, in the art of semiconductor processing, the surface roughness of a susceptor surface is preferably as smooth as

possible because a smooth surface provides better heat transfer to a workpiece mounted thereon and less contamination by the deposition of foreign materials (Col.1, lines 7 – 15, Col.3, lines 9 – 14, and Col.4, lines 5 – 13). A preferred surface roughness taught by Kubota et al. is 0.01 μm to 0.1 μm (i.e., less than 10 microinches). Therefore, it would have been obvious to one of ordinary skill in the art to perform the process of the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton on a susceptor having as smooth a surface as possible, including a surface finish of less than about 10RA, with the reasonable expectation of successfully and advantageously obtaining a susceptor that is corrosion resistant, provides good heat transfer to a substrate mounted thereon, and is not easily contaminated by the deposition of foreign materials.

7. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Toyoda et al. (JP 09-328382 A) in view of Ohashi et al. (USPN 6,139,983), in further view of Itoh et al. (USPN 6,287,683 B1), Tomita et al. (USPN 4,637,684), and Morton (USPN 6,162,495), and in further view of Ohmi et al. (USPN 6,215,806 B1).
8. The combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton teaches all the limitations of **Claim 9** as set forth above in paragraph 10, except for a method further comprising the step of annealing the magnesium fluoride coating at a temperature of at least about 600° C. Specifically, the aforementioned combination of references is silent regarding any further annealing step. However, as set forth above in paragraph 10, it would have been obvious to one of ordinary skill in the art

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to desire to deposit / form the magnesium fluoride coating of Toyoda et al. in such a manner that the coating is sufficiently dense to minimize or eliminate defects, such as voids, and pin-holes in the coating (i.e., to form a coating having a high density). Ohmi et al. teaches that metal fluoride films can be densified by annealing the films at a temperature of, for example, 600° C, after forming the films (Col.11, lines 51 – 61, Col.13, lines 22 – 28). This temperature is within the applicant's claimed range of "at least about 600° C". It would have been obvious to one of ordinary skill in the art to anneal the magnesium fluoride coating of the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton at a temperature of, for example, 600° C with the reasonable expectation of successfully and advantageously increasing the density of the film, thereby insuring that the coating is free from defects (e.g., voids) and pin-holes and provides optimum corrosion resistance.

9. Claims 13 – 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Toyoda et al. (JP 09-328382 A) in view of Ohashi et al. (USPN 6,139,983), in further view of Itoh et al. (USPN 6,287,683 B1), Tomita et al. (USPN 4,637,684), and Morton (USPN 6,162,495), and in further view of Kawamata et al. (USPN 5,958,155).
10. The combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton teaches all the limitations of **Claim 13** as set forth above in paragraph 10, except for a method wherein the PVD coating (e.g., sputtering) is performed at a temperature of at least about 600° C. However, Toyoda et al. does teach using a sputtering

method in general to deposit the magnesium fluoride film (Figure 1, paragraphs [0006] – [0008], [0011] – [0012], and [0014]). Kawamata et al. teaches that, in the art of sputter depositing a magnesium fluoride film, it is desirable to heat the magnesium fluoride sputtering target to a temperature ranging from 650 to 1100° C (i.e., at least about 600° C) so that (1) the magnesium fluoride is ejected from the target in molecular form, thereby improving the composition of the deposited film, and (2) the sputtering yield is improved, thereby increasing the film formation rate (Col.3, lines 34 – 47, Col.4, lines 4 – 11, and Col.5, lines 1 – 8). Therefore, it would have been obvious to one of ordinary skill in the art to heat the magnesium fluoride sputtering target to a temperature ranging from 650 to 1100° C (i.e., at least about 600° C) in the process of the combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton with the reasonable expectation of successfully and advantageously improving the composition of the deposited magnesium fluoride film and the film formation / sputtering rate, as taught by Kawamata et al. The combination of Toyoda et al., Ohashi et al., Itoh et al., Tomita et al., and Morton teaches all the limitations of **Claims 14 and 15** as set forth above in paragraph 10, except for a method wherein the PVD (e.g., sputtering) coating step is performed in an inert atmosphere, specifically an atmosphere comprising nitrogen. Toyoda et al. does teach using a sputtering method in general to deposit the magnesium fluoride film (Figure 1, paragraphs [0006] – [0008], [0011] – [0012], and [0014]) but is silent regarding the nature of the atmosphere. Kawamata et al. teaches that, in the art of sputter depositing a magnesium fluoride film, it is desirable to sputter deposit the film

in an atmosphere comprising nitrogen ("an inert atmosphere") in order to insure that the magnesium fluoride is ejected from the target in molecular form (not atomic form), thereby improving the composition of the deposited film (Col.3, lines 25 – 29, Col.5, lines 9 – 20 and 31 – 38; and Col.6, lines 15 – 16). Therefore, it would have been obvious to one of ordinary skill in the art to perform the magnesium fluoride sputter depositing process of Toyoda et al. in a nitrogen (i.e., inert) atmosphere, as taught by Kawamada et al., with the reasonable expectation of successfully and advantageously insuring that the magnesium fluoride is ejected from the target in molecular form (not atomic form), thereby improving the composition of the resultant film.

11. Claims 1, 3 – 6, 10, 11, and 16 – 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tomita et al. (USPN 4,637,684) in view of Morton (USPN 6,162,495).

12. Regarding independent **Claim 1**, Tomita et al. teaches a method of forming a coated part, specifically a coated prism of a waveguide, the method comprising coating the prism with magnesium fluoride by evaporation (Abstract, Col.4, lines 4 – 7 and 36 – 54). Tomita et al. teaches that the coating process is performed by heating the substrate to the order of 300° C during the evaporation in order to form a film of low porosity (i.e., high density) and prevent any fluctuation of the refractive index of the film (Col.4, lines 49 – 54). Tomita et al. does not explicitly teach that the magnesium fluoride film has a density of at least about 85% and a purity of at least about 99%.

Specifically, Tomita et al. is silent regarding the exact density and purity of the magnesium fluoride coating, as well as the specific pressure used during the deposition process. Morton teaches that, by using a low pressure of 10^{-6} torr or less during a magnesium fluoride deposition process, a pure, dense magnesium fluoride film can be formed (e.g., without contaminants such as oxygen or hydrogen) (Col.3, lines 48 – 66). Therefore, it would have been obvious to one of ordinary skill in the art to deposit the magnesium fluoride film of Tomita et al. at a pressure of 10^{-6} torr or less with the reasonable expectation of successfully and advantageously using a deposition process pressure that leads to a pure, dense magnesium fluoride film, as desired by Tomita et al. The deposition of a magnesium fluoride film at these process conditions would have inherently produced a magnesium fluoride coating having a density of at least about 85% and a purity of at least about 99%, as required by Claim 1, because the aforementioned magnesium fluoride deposition process conditions are identical to the applicant's disclosed magnesium fluoride deposition process conditions that achieve the claimed coating density and purity (see, for example, paragraphs [0021], [0023], and [0025] of the applicant's specification). The combination of Tomita et al. and Morton does not explicitly teach that the coating "reduces corrosion of said component part upon exposure to a corrosive environment". However, as the magnesium fluoride film of the combination of Tomita et al. and Morton is deposited on a "component part" and is both pure and dense (see the discussion above), the film would inherently reduce the corrosion of the component part (i.e., the prism / waveguide) upon exposure to a corrosive

environment. Regarding **Claim 3**, the combination of Tomita et al. and Morton does not explicitly teach that the magnesium fluoride coating has a density of about 100%. However, such a density would have inherently been achieved by using the process conditions (i.e., temperature and pressure) taught by the combination of Tomita et al. and Morton (see, for example, paragraph [0021] of the applicant's specification).

Regarding **Claim 4**, the combination of Tomita et al. and Morton does not explicitly teach that the corrosive environment comprises fluorine. However, as the magnesium fluoride film of the combination of Tomita et al. and Morton is deposited on a "component part" and is both pure and dense (see the discussion above), the film would inherently reduce the corrosion of the component part (i.e., the prism / waveguide) upon exposure to a corrosive environment of any sort, including a corrosive environment comprising fluorine. Please note that the applicant's claims do not require actually exposing the component part to a corrosive environment.

Regarding **Claims 5 and 6**, the combination of Tomita et al. and Morton also teaches that the coating step is performed at a pressure of not more than about 1×10^{-5} torr (Claim 5) and at a temperature of at least 250° C (Claim 6) (see the discussion of Claim 1 above). Regarding **Claims 10 and 11**, the combination of Tomita et al. and Morton also teaches that the coating is performed by chemical vapor deposition at a temperature of at least about 300° C (Col.4, lines 40 – 54 of Tomita et al.). Regarding **Claims 16 and 17**, the combination of Tomita et al. and Morton does not explicitly teach that the coating has a grain size of less than about 30 microns, particularly less than about 3 microns. However, the deposition process

conditions taught by the aforementioned combination of references (i.e., a temperature on the order of 300° C (as taught by Tomita et al.) and a pressure of, for example, 10⁻⁶ torr or less (as taught by Morton)) would have inherently produced a magnesium fluoride coating having the grain size claimed by the applicant, because the aforementioned magnesium fluoride deposition process conditions are identical to the applicant's disclosed magnesium fluoride deposition process conditions used to obtain the claimed coating. Regarding **Claims 18 and 19**, the combination of Tomita et al. and Morton also teaches that the coating has a thickness of less than about 2 microns, particularly less than about 1 micron (Col.4, lines 47 – 50 of Tomita et al., which teaches a coating thickness of "several 1000 Å", which is equivalent to "several hundred nm" and therefore within the applicant's claimed range of less than about 1 micron (i.e., 1000 nm)).

13. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tomita et al. (USPN 4,637,684) in view of Morton (USPN 6,162,495), in further view of Itoh et al. (USPN 6,287,683 B1).

14. The combination of Tomita et al. and Morton teaches all the limitations of **Claim 2** as set forth above in paragraph 18, except for a method wherein the magnesium fluoride coating has a density of between about 85 – 90%. However, Tomita et al. does desire to deposit a magnesium fluoride film having a low porosity in general (Col.4, lines 49 – 54). Itoh et al. teaches that, in the art of depositing a magnesium fluoride film by vacuum deposition, EB deposition, sputtering, etc., the packing rate /

density of the film can be adjusted by controlling the degree of vacuum (i.e., the pressure) and the film-forming temperature during the process (Col.4, lines 64 – 67, Col.5, lines 1 – 24). In other words, Itoh et al. teaches that the temperature and pressure in a magnesium fluoride deposition process are result / effective variables that are used to control the density of the deposited film. The lower the degree of vacuum (i.e., the higher the pressure) and the lower the film-forming temperature, the lower the density of the deposited film (Col.5, lines 10 – 14). Consequently, the lower the pressure and the higher the temperature, the higher the density of the deposited film. It would have been obvious to one of ordinary skill in the art to optimize as result / effective variables the temperature and pressure of the magnesium fluoride deposition process of the combination of Tomita et al. and Morton (and therefore to optimize the film density) through routine experimentation in order to obtain a magnesium fluoride film that has a “low porosity” (i.e., a high density), as desired by Tomita et al. The exact density of the film would have been determined by a purveyor in the art, depending on the degree of “low porosity” desired.

15. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tomita et al. (USPN 4,637,684) in view of Morton (USPN 6,162,495), in further view of Itoh et al. (USPN 6,287,683 B1), and in further view of Ohmi et al. (USPN 6,215,806 B1).

16. The combination of Tomita et al., Morton, and Itoh et al. teaches all the limitations of **Claim 9** as set forth above in paragraph 20, except for a method further comprising

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the step of annealing the magnesium fluoride coating at a temperature of at least about 600° C. Specifically, the aforementioned combination of references is silent regarding any further annealing step. However, Tomita et al. does desire to obtain a magnesium fluoride film having a low porosity in general (Col.4, lines 49 – 54). Ohmi et al. teaches that metal fluoride films can be densified by annealing the films at a temperature of, for example, 600° C, after forming the films (Col.11, lines 51 – 61, Col.13, lines 22 – 28). This temperature is within the applicant's claimed range of "at least about 600° C". It would have been obvious to one of ordinary skill in the art to anneal the magnesium fluoride film of the combination of Tomita et al., Morton, and Itoh et al. at a temperature of, for example, 600° C with the reasonable expectation of successfully and advantageously increasing the density of the film, thereby reducing the porosity of the film and preventing any refractive index fluctuation of the film, as desired by Tomita et al.

(10) Response to Argument

17. Applicant's arguments filed on 5/7/2004 have been fully considered but they are not persuasive.

18. Regarding Claims 1 – 7, the applicant argues that (1) Toyoda et al. is silent regarding the density and purity of the magnesium fluoride coating, and thereby does not teach or suggest a magnesium fluoride coating having a density of at least about 85% and a purity of at least about 99%; (2) Ohashi is also silent regarding the density and purity of the magnesium fluoride coating; (3) Itoh is also silent regarding the density and purity of the magnesium fluoride coating; (4) Tomita is silent

regarding the specific density and purity of the magnesium fluoride coating; and (5) Morton is silent with respect to the density and purity of the magnesium fluoride coating. As such, the applicant argues that there is no teaching or suggestion to combine the references to obtain a magnesium fluoride coating having a density of at least about 85% and a purity of at least about 99%, as required by independent Claim 1. In response, this argument is not convincing for the following reasons. To begin, the examiner admits that none of the aforementioned references explicitly teaches depositing a magnesium fluoride coating having a density of at least about 85% and a purity of at least about 99%. However, the test of obviousness is not an express suggestion of the claimed invention in any or all references, but rather what the references taken collectively would suggest to those of ordinary skill in the art presumed to be familiar with them (*In re Rosselet*, 146 USPQ 183). In this case, the examiner maintains that the combination of references, when viewed collectively, reasonably suggests performing the applicant's claimed method. Briefly, Toyoda et al. is silent regarding the density and purity of the magnesium fluoride coating, as well as the specific process conditions (e.g., temperature and pressure) used to deposit the coating. However, Toyoda et al. does teach that the magnesium fluoride target used in the deposition process has a purity of 99.5% (paragraph [0014]). This teaching would at least suggest to one of ordinary skill in the art that Toyoda et al. is concerned with and desires depositing a coating having a high purity. As such, one of ordinary skill in the art would have been motivated to seek-out appropriate process conditions to deposit a magnesium fluoride film of as high purity as possible.

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Ohashi et al. teaches an analogous process of coating a wafer-supporting member with a magnesium fluoride layer in order to protect the member from corrosion by halogen-containing gases (Abstract, Col.1, lines 53 – 67, Col.2, lines 1 – 8, and Col.3, lines 31 – 61). Ohashi et al. teaches that the method of producing the fluoride layer should be such that defects and pin-holes are not formed in the film (Col.6, lines 15 – 27). Therefore, it would have been obvious to one of ordinary skill in the art to desire to deposit / form the magnesium fluoride coating of Toyoda et al. in such a manner that the coating is free of defects and pin-holes (as taught to be desirable by Ohashi et al.) so that the coating provides the aluminum nitride component with optimum corrosion resistance. The examiner maintains that a denser, more highly packed coating would be reasonably expected to have fewer defects (e.g., voids, holes) and pin-holes than a porous, less dense coating. As such, one of ordinary skill in the art would have been motivated to seek-out appropriate process conditions to deposit and form the magnesium fluoride coating of Toyoda et al. in such a manner that the coating is sufficiently dense to minimize or eliminate defects, such as voids and pin-holes, in the coating. Itoh et al., Tomita et al., and Morton are cited to show that the temperature and pressure (i.e., process conditions) utilized in a magnesium fluoride deposition process are known in the art to be result / effective variables, and the specific temperature and pressure values used by the applicant in the claimed and disclosed magnesium fluoride deposition process were known in the art to produce pure, dense magnesium fluoride films. Since one of ordinary skill in the art would have been motivated to seek-out and

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employ deposition process conditions that yield a dense, pure magnesium fluoride film, and Itoh et al., Tomita et al., and Morton teach such conditions, it would have been obvious to utilize such deposition conditions (i.e., temperature and pressure) to obtain the protective magnesium fluoride film desired by Toyoda et al. Since these conditions are the same as the conditions utilized by the applicant, the resultant magnesium fluoride film would have inherently had the same density and purity as that of the applicant.

19. The applicant also argues that a desire to have a pinhole and defect-free film is not a suggestion or motivation to deposit a film having a density of at least about 85%, as required by Claim 1. In the same vane, the applicant states that the examiner erroneously equates the statement of Ohashi that the coating be free of defects and pinholes with having a density of at least about 85%, since a film need not be highly pure or dense in order to be free of defects and pinholes. In response, this argument is not convincing. To begin, it is important to note that the overall goal of Toyoda et al. is to provide a base material with excellent durability and corrosion resistance, and this is done by forming a metal (e.g., magnesium) fluoride layer on the base material (Abstract). While Ohashi's teaching that the magnesium fluoride layer should be free of defects and pinholes may not directly be a teaching of a film having a density of at least about 85%, the examiner maintains that a denser, more highly packed coating would be reasonably expected by one of ordinary skill in the art to have fewer defects (e.g., voids, holes) and pin-holes than a porous, less dense coating and to provide better durability and corrosion resistance, as desired by

Toyoda et al. (e.g., because a less dense coating having higher porosity would be reasonably expected to allow more contaminants through to the base material (i.e., due to the pores / voids in the coating) than a more dense coating would).

20. Regarding Claims 1 and 3 – 6, the applicant argues that neither Tomita nor Morton teaches or suggests a magnesium fluoride coating having a density of at least about 85% and a purity of at least about 99%, and therefore the references cannot be combined in a manner which yields a magnesium fluoride coating having the density and porosity recited in Claim 1. In response, the examiner maintains that the combination of Tomita and Morton teaches performing the magnesium fluoride deposition process at the high temperature (e.g., around 300° C) and low pressure (e.g., 10^{-6} torr or less) disclosed and claimed by the applicant (see paragraph 18 above). The deposition of a magnesium fluoride film at these process conditions would have inherently produced a magnesium fluoride coating having a density of at least about 85% and a purity of at least about 99%, as required by Claim 1, because the aforementioned magnesium fluoride deposition process conditions are identical to the applicant's disclosed magnesium fluoride deposition process conditions that achieve the claimed coating density and purity (see, for example, paragraphs [0021], [0023], and [0025] of the applicant's specification).

21. Also regarding Claims 1 and 3 – 6, the applicant submits that it is more difficult and expensive to deposit films at lower (versus higher) pressures, and as such, one of ordinary skill in the art would not have been motivated to deposit a magnesium fluoride coating (e.g., the coating of Tomita) at the low pressures disclosed in Morton

when a satisfactory process existed that utilizes higher deposition pressures. In response, this argument is not convincing. To begin, please note that the fact that a combination would not have been made by businessmen for economic reasons does not preclude a finding of *prima facie* obviousness (see MPEP 2145(VII)). Further, Tomita et al. teaches that the coating process is performed in order to produce a magnesium fluoride film of low porosity (i.e., high density) and prevent any fluctuation of the refractive index of the film (Col.4, lines 49 – 54), but is silent regarding the exact density and purity of the magnesium fluoride coating, as well as the specific pressure used during the deposition process. As such, one of ordinary skill in the art would have been motivated to seek-out and utilize a process pressure sufficient to yield a film of low porosity / high density. Morton teaches that, by using a low pressure of 10^{-6} torr or less during a magnesium fluoride deposition process, a pure, dense magnesium fluoride film can be formed (e.g., without contaminants such as oxygen or hydrogen) (Col.3, lines 48 – 66). This teaching provides sufficient motivation to utilize a pressure of 10^{-6} torr or less during the magnesium fluoride deposition process of Tomita et al., i.e., because such a pressure is advantageous in producing a pure, dense film, which is specifically desired by Tomita et al.

22. Regarding Claim 9, the applicant argues that the only heat treatment of a magnesium fluoride film described in Ohmi is in a temperature range of 150 to 450° C, not at least about 600° C, as recited in the claim. In response, although Ohmi does not explicitly teach heat treating magnesium fluoride at a temperature of at least about 600° C, Ohmi does teach that metal fluoride films can be densified by

annealing the films at a temperature of, for example, 600° C, after forming the films (Col.11, lines 51 – 61, Col.13, lines 22 – 28). As such, it is the examiner's position that it would have been obvious to one of ordinary skill in the art to anneal the magnesium fluoride film at any temperature sufficient to densify the film, including from 150 to 450° C, and even up to around 600° C, with the reasonable expectation of successfully and advantageously densifying the film, regardless of the exact temperature utilized in the annealing process. Please note that, in general, differences in temperature will not support the patentability of subject matter encompassed by the prior art unless there is evidence indicating that such temperature is critical (see MPEP 2144.05(II)(A)).

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

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For the above reasons, it is believed that the rejections should be sustained.

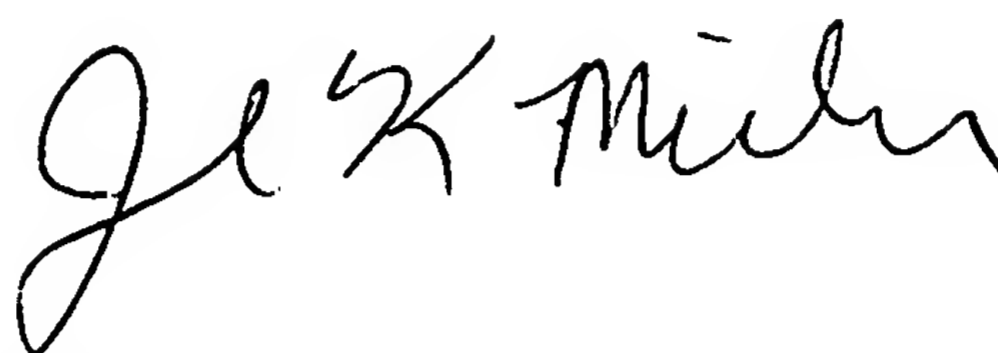
Respectfully submitted,

David P Turocy



Conferees:

Jennifer Kolb-Michener



Timothy Meeks



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Patent application open disclosure

Document No. H9-328382

ALUMINUM NITRIDE BASE MATERIAL FOR SEMICONDUCTOR PRODUCTION UNIT
AND ITS PRODUCTION

半導体製造装置用の窒化アルミニウム基材及びその製造方法

Toyoda, Seiji
Kuromitsu, Yoshio
Sugamura, Kunio

UNITED STATES PATENT AND TRADEMARK OFFICE

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Inventor : Toyoda Seiji Inside Mitsubishi Materials Inc.
General Research Facility 1-297
Kitabukuro-cho, Omiya-shi, Saitama-ken

: Kuromitsu Yoshio Inside Mitsubishi
Materials Inc. General Research Facility
1-297 Kitabukuro-cho, Omiya-shi, Saitama-
ken Sugamura Kunio Inside Mitsubishi
Materials Inc. General Research Facility
1-297 Kitabukuro-cho, Omiya-shi, Saitama-
ken

Applicant : Mitsubishi Materials Inc
1-297 Kitabukuro-cho, Omiya-shi, Saitama-
ken

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54. Name of Invention: ALUMINUM NITRIDE BASE MATERIAL FOR SEMICONDUCTOR
PRODUCTION UNIT AND ITS PRODUCTION

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72. Inventor: Toyoda Seiji

1-297 Kitabukuro-cho, Omiya-shi, Saitama-ken
Inside Mitsubishi Materials Inc. General Research Facility

72. Inventor: Kuromitsu Yoshio

1-297 Kitabukuro-cho, Omiya-shi, Saitama-ken
Inside Mitsubishi Materials Inc. General Research Facility

72. Inventor: Sugamura Kunio

1-297 Kitabukuro-cho, Omiya-shi, Saitama-ken
Inside Mitsubishi Materials Inc. General Research Facility

71. Applicant:

Mitsubishi Materials Inc
1-297 Kitabukuro-cho, Omiya-shi, Saitama-ken

74. Representative: Patent Agent Suda Masayoshi

Description

54. Title of invention

ALUMINUM NITRIDE BASE MATERIAL FOR SEMICONDUCTOR PRODUCTION UNIT AND ITS PRODUCTION

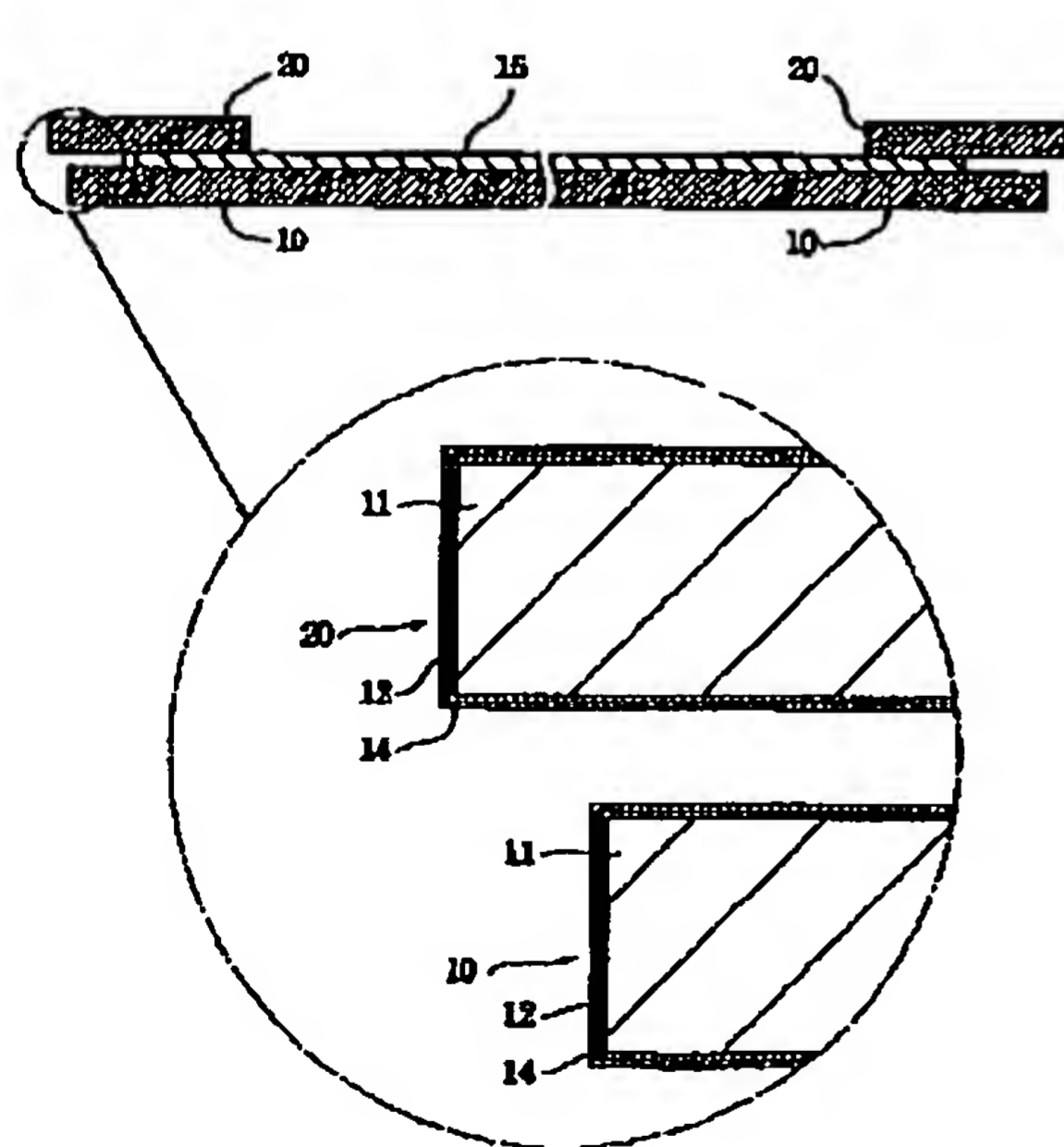
57. Abstract

Problem to Solve:

To obtain aluminum nitride base material with outstanding thermal conductivity, excellent durability against heat shocks, and good corrosion resistance, especially against fluorine gas.

Solution:

Aluminum nitride base material 10, 20 for semiconductor production unit is consisted from aluminum nitride sintered compact 11, oxidized layer 12 which is formed on the surface of this sintered compact 11 by oxidizing the sintered compact, and metal fluoride layer 14 formed on the surface of this oxidized layer 12.



Scope of claims

Claim item 1:

Aluminum nitride base material for semiconductor production unit that is characterized by aluminum nitride sintered compact (11), oxidized layer (12) formed on the surface of said sintered compact by oxidizing said sintered compact, and metal fluoride layer (14) formed on the surface of said oxidized layer (12).

Claim item 2:

Aluminum nitride base material mentioned in claim item 1 whose metal fluoride layer's vapor pressure is 0.1 atm or less at 600°C.

Claim item 3:

Production method of aluminum nitride base material for semiconductor production unit wherein oxidized layer (12) is formed on the surface of aluminum nitride sintered compact (11) by oxidizing said sintered compact, and metal fluoride layer (14) is formed on the surface of said oxidized layer (12) by vacuum deposition or sputtering technique.

Detailed description of the invention:

【 0 0 0 1 】

Technical area of invention:

This invention is about aluminum nitride base material, a production part used in semiconductor production processes, and its production method. Namely, this invention is about aluminum nitride base material used as wafer holder or susceptor, or as electrodes for plasma reactions, in semiconductor production units like Chemical Vapor Deposition ("CVD") device and dry etching device. The invention is also about the production method of said aluminum nitride base material.

【 0 0 0 2 】

Conventional technology:

As semiconductor devices have become extremely smaller and highly dense, semiconductor production process technology attaches more importance to control of CVD and dry etching devices and ply leaf production subjects have become widely adopted. With miniaturization reaching the half micron scale, the semiconductor production process must not only reduce the density of particles in clean rooms, but it has become more important to avoid producing particles during production process and also to discourage

particles from attaching to wafer.

【 0 0 0 3 】

In CVD device and dry etching device, base materials for wafer holders or susceptors, as well as for plasma reaction electrodes are placed in the device interior temperature of about 500°C during production process and are exposed to exterior room temperature after the process. As this heat cycle is repeated in the ply leaf process, the base material is required to possess high durability against heat shocks. Additionally, said base material must be effective in conducting heat from heater to wafer, etc. Further, said base material must not be corroded from film forming gas and etching gas. Traditionally, to satisfy these requirements, materials like silicon carbide, aluminum nitride, alumite treated aluminum, and graphite were used for base materials since these possess superb heat shock durability, excellent heat conductivity rate and anti-corrosion characteristics.

【 0 0 0 4 】

Problems to be solved by the invention:

But, as the CVD film forming speed and dry etching speed has reached much higher level, base materials created from silicon carbide, aluminum nitride, alumite treated aluminum, and graphite are showing more damages and shorter life span. Thus, there is a demand for base materials with better resistance against corrosion and heat shocks. Aluminum nitride, compared to other silicon carbide materials, is regarded favorably since it has better heat conductivity, anti-corrosion characteristics and durability against heat shocks. However, when aluminum nitride is exposed to film-forming fluoride gas (CF_6 , MoF_6 etc.), etching gas (CF_4 , CBrF_3 , SF_6 , $\text{C}_2\text{Cl}_2\text{F}_4$, C_3F_3 , CHF_3 , NF_3 , CH_2F_2 , CCl_3F_2 , etc.), or cleaning gas (ClF_3 , etc.) that are used by CVD and etching devices, fluoride element in the gas reacts to aluminum element in the aluminum nitride to produce fluoride film. This fluoride film at first attaches to the surface of aluminum nitride. But, it eventually separates itself from the surface, floats through the interior of the CVD and dry etching devices, and finally attaches itself on the wafer surface. This posed a problem.

【 0 0 0 5 】

The purpose of this invention is to provide aluminum nitride base material with outstanding thermal conductivity, excellent durability against heat shocks, and good corrosion resistance, especially against fluorine gas, as well as to provide production method of the said base material.

【 0 0 0 6 】

Means of solving the problems:

As the blown up Figure 1 shows, the Claim Item 1 of the invention relates to aluminum nitride base material 10, 20 for semiconductor production unit which is consisted from aluminum nitride sintered compact 11, oxidized layer 12 which is formed on the surface of this sintered compact 11 by oxidizing the sintered compact, and metal fluoride layer 14 formed on the surface of this oxidized layer 12.

The Claim Item 2 of the invention relates to aluminum nitride base material for semiconductor production unit whose metal fluoride layer's vapor pressure is 0.1 atm or less at 600°C. If metal fluoride was used

whose vapor pressure at 600°C is higher than 0.1 atm, when CVD film is formed, vaporized metal fluoride material mixes with gas from raw material (film-forming gas) causing difficulty in forming films with desired composition and characteristics.

【 0 0 0 7 】

The Claim Item 3 of the invention relates to production method of aluminum nitride base material for semiconductor production unit wherein oxidized layer 12 is formed on the surface of aluminum nitride sintered compact 11 by oxidizing said sintered compact, and metal fluoride layer 14 is formed on the surface of said oxidized layer 12 by vacuum deposition or sputtering technique.

【 0 0 0 8 】

First, the said base material of this invention possesses high heat shock resistant characteristics of aluminum nitride sintered compact 11 since it has added metal fluoride layer 14 formed by vacuum deposition or sputtering technique from oxidized layer which was formed on the surface of aluminum nitride sintered compact by oxidizing said sintered compact. This high heat shock resistance is due to high heat conductivity and relatively low heat expansion coefficient of the aluminum nitride. Second, oxidized layer 12 not only promotes adhesion between metal fluoride layer 14 and aluminum nitride sintered compact 11, but it also prevents reaction between metal fluoride layer and aluminum nitride sintered compact during formation of metal fluoride layer by gas phase method like deposition process. And third, metal fluoride layer prevents reaction between aluminum nitride sintered compact and fluoride gas (ClF_3 , etc.) which is used for CVD film-forming process.

【 0 0 0 9 】

Mode of application of the invention:

Said aluminum nitride base material of this invention is used for wafer holder or susceptor, or for plasma reaction electrodes, in semiconductor production units like CVD or dry etching devices. In addition to those mentioned above, semiconductor production units include oxidation system, diffusion apparatus, ion implantation device, vacuum deposition device, sputtering device, and lithography device. Said wafers could include wafers for semiconductor base plate such as silicon wafers and GaAs wafers. For example, as is shown in Figure 1, in CVD devices, silicon wafer 15 is placed on susceptor 10 made from aluminum nitride base material and is held by clamp ring 20, also made from aluminum nitride base material.

【 0 0 1 0 】

CVD devices include thermal CVD device, plasma CVD device, light CVD device where light irradiation causes deposition. In this CVD device, on the surface of wafer, semiconductor base plate, is formed thin films of SiO_2 (silicon dioxide), PSG (phosphorus glass), BSG (boron glass), ASG (arsenic glass), Si_3N_4 (silicon nitride), polycrystal silicon, single-crystal silicon (epitaxial method), W (tungsten), Mo (molybdenum), WSi_2 , MoSi_2 , TaSi_2 , or TiSi_2 .

Material gas (gas for film forming) for forming these thin films include SiH_4 , SiH_2Cl_2 , SiHCl_3 , SiCl_4 , SiBr_4 , WF_6 , MoF_6 , TaCl_5 , and TiCl_4 . As cleaning gas, ClF_3 and others are used. Dry etching devices include plasma etching device and reactive ion etching device. In the dry etching devices, part of or entire thin films formed on surface of semiconductor base plate wafer are removed. Etching gas used includes CF_4 , CF_4+O_2 , CBrF_3 , CCl_4+O_2 , Cl_2 , SiCl_4 , SF_6 , $\text{C}_2\text{Cl}_2\text{F}_4$, C_3F_8 , CHF_3 , NF_3 , CH_2F_2 and CCl_2F_2 .

【 0 0 1 1 】

Aluminum nitride base material is mainly composed from aluminum nitride sintered compact. This base material is formed into different shapes according to specification of semiconductor production unit – such as plate shape, ring shape, bulk shape and table shape. This aluminum nitride sintered compact is not

limited to sintered compact made only from aluminum nitride. The sintered compact could have aluminum nitride as its main component with additives like CaO and Y_2O_3 . For example, aluminum nitride sintered compact is obtained from a compound of aluminum nitride powder mixed with 5 wt% of sintering agent like Y_2O_3 . This compound is sintered in N_2 atmosphere at 1700 - 1800°C under constant pressure. The oxidized layer is created on the surface of said sintered compact by heating the aluminum nitride sintered compact at 1100 – 1500°C for 3 – 0.5 hours in the atmosphere where oxygen partial pressure is 1×10^{-2} atm or more and moisture partial pressure is 1×10^{-3} atm or less. The processing time could be shortened with higher temperature. This heat treatment will oxidize the surface of the aluminum nitride sintered compact, creating a porous oxidized layer (Al_2O_3 layer) with porosity of 0.01 – 15 bulk %. The oxidized layer forms to thickness of 1 – 10 μm . If the thickness is less than 0.1 μm , the corrosion resistance of the base material is insufficient, while if it is over 10 μm , the oxidized layer tends to develop crack or fracture.

【 0 0 1 2 】

Metal fluoride layer is formed on this oxidized surface by vacuum deposition or sputtering process. The metal fluoride layer forms to thickness of 0.01 – 5 μm .

If the thickness is less than 0.01 μm , the corrosion resistance of the base material is insufficient, while if it is over 5 μm , the metal fluoride layer tends to develop crack or fracture. Example of metal fluoride material would be AlF_3 , MgF_2 and ZrF_4 .

【 0 0 1 3 】

Working example:

Next, the said invention is further explained with working examples and comparative examples.

< Working example 1 >

First, a 50 x 50 mm square piece of aluminum nitride sintered compact is cut out. This is heat-treated in O_2 atmosphere at 1300°C for 1 hour to form oxidized layer on the surface of sintered compact, where the said layer is made of 3.0 μm thick porous Al_2O_3 layer. Next, using a 99.5% pure AlF_3 target, formed 0.1 μm thick AlF_3 layer on the surface of said oxidized layer by a high frequency sputtering process under condition of 300W power and 10 rpm base plate rotation. This aluminum nitride base material composed from aluminum nitride sintered compact, oxidized layer, and AlF_3 layer is designated as working example 1.

【0014】

< Working example 2 >

In a similar manner as working example 1 above, except for using 99.5% pure MgF_2 target rather than AlF_3 target under working example 1, AlN sintered compact was created with 0.1 μm thick layer of MgF_2 . This aluminum nitride base material composed from aluminum nitride sintered compact, oxidized layer, and MgF_2 layer is designated as working example 2.

【 0 0 1 5 】

< Working example 3 >

In a similar manner as working example 1 above, except for using 99.5% pure Zr F₄ target rather than Al F₃ target under working example 1, Al N sintered compact was created with 0.1 μm thick layer of Zr F₄. This aluminum nitride base material composed from aluminum nitride sintered compact, oxidized layer, and Zr F₄ layer is designated as working example 3.

【 0 0 1 6 】

< Comparative example 1 >

Aluminum nitride sintered compact of the same shape as under working example 1 was used. Nothing was formed on the surface of this sintered compact. This aluminum nitride base material was designated as comparative example 1.

【 0 0 1 7 】

< Comparative example 2 >

Aluminum nitride sintered compact of the same shape as under working example 1 was heat-treated in O₂ atmosphere at 1300°C for 1 hour to form oxidized layer on the surface of sintered compact, where the said layer was made of 3.0 μm thick porous Al₂O₃ layer. This aluminum nitride base material was designated as comparative example 2.

【 0 0 1 8 】

< Comparison test >

In order to evaluate fluoride gas resistance characteristics of aluminum nitride base materials from working examples 1 through 3 and from comparative examples 1 and 2, these base materials were placed in a chamber made from Al for a period of 10 hours in Cl F₃ gas atmosphere at 600°C. The base materials were weighed before and after the comparison test to examine weight changes. In addition, the base material surface was observed both before and after the comparison test with an optical microscope for any changes. The result is shown in Table 1.

【 0 0 1 9 】

Table 1:

Test material	Weight change (%)	Surface texture change
Working example 1	0.01	None
Working example 2	0.02	None
Working example 3	0.02	None
Comparative example 1	0.25	numerous fine extraneous matters
Comparative example 2	0.06	None

【 0 0 2 0 】

As is clearly shown in Table 1, the comparative test produced little weight change and no surface texture change with the aluminum nitride base materials in working example 1 through working example 3. However, aluminum nitride base material from comparative example 1 produced noticeable weight change and numerous fine extraneous matters were observed on the base material surface. Namely,

under the comparative example 1, it is considered that reaction between aluminum nitride and Cl F_3 gas caused formation of numerous fine reaction products on the surface and these detached themselves from the base material. With respect to aluminum nitride base material of comparative example 2, although no change was observed in the surface texture, weight change was larger than that of working example 1. This is considered to have resulted from partial reaction between aluminum nitride and Cl F_3 gas.

【 0 0 2 1 】

Effect of the invention:

As was stated above, this invention formed metal fluoride layer via oxidized layer on the surface of aluminum nitride base material. Compared to base materials made only of conventional aluminum nitride sintered compact with high heat conductivity and good durability against heat shocks, the aluminum nitride base material under this invention adds to these characteristics excellent anti-fluoride gas characteristics. Therefore, said aluminum nitride base material under this invention will excel as wafer holder or susceptor and as plasma reaction electrodes in semiconductor production units especially since such units use fluoride gas.

Summary description of the invention:

Figure 1:

Blow up of cross section of CVD device using aluminum nitride base material of this invention for susceptor and clamp ring.

Explanation of symbols:

- 10 Aluminum nitride base material (susceptor)
- 20 Aluminum nitride base material (clamp ring)
- 11 Aluminum nitride sintered compact
- 12 Oxidized layer
- 14 Metal fluoride layer
- 15 Silicon wafer

Figure 1:

- 10 Aluminum nitride base material (susceptor)
- 20 Aluminum nitride base material (clamp ring)
- 11 Aluminum nitride sintered compact
- 12 Oxidized layer
- 14 Metal fluoride layer
- 15 Silicon wafer

【図1】

- 10 酸化アルミニウム基材(サセブタ)
- 20 酸化アルミニウム基材(クランプリング)
- 11 酸化アルミニウム膜
- 12 酸化膜
- 14 金属フッ化物膜
- 15 シリコンウエハー

